PHONETIC INTERPRETATION

PAPERS IN LABORATORY PHONOLOGY VI

EDITED BY
JOHN LOCAL, RICHARD OGDEN
AND ROSALIND TEMPLE

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Contents

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Introduction

JOHN LOCAL, RICHARD OGDEN AND
ROSALIND TEMPLE

There is a long tradition in Europe and North America of employing laboratory techniques to explore questions within phonetics (Hardcastle and Laver 1997; Ohala, Bronstein, Busà, Lewis and Weigel 1999). However, the coherent use of laboratory techniques to address phonological questions has a somewhat shorter history. Indeed the term 'Laboratory Phonology' (LP), which features in the title of this book, was coined by Janet Pierrehumbert only some ten years ago to characterise a growing body of experimental research on sound structure, its representation and its physical exponents (Kingston and Beckman 1990; Pierrehumbert, Beckman and Ladd 1996). Up to that point it had been typical for workers in other areas such as psychology to borrow the ideas from phonology and apply them within experimental settings to address the concerns of their own disciplines rather than to illuminate linguistic theory *per se*.

Nonetheless, over forty years ago the linguist, phonetician and phonologist J. R. Firth wrote of taking 'linguistics into the laboratory' (1957: 25). The point of doing this, Firth was at pains to emphasise, was not to engage in an 'experimental phonetics' ('a very different scientific procedure') but rather to support the exploration of the relationships between phonetics, phonology and the 'grammar' of language. Revisiting this matter in 1959, he writes: 'The linguist will, of necessity, have in mind tentative analysis at the phonological and grammatical levels, and unless the results of laboratory experiments throw light on findings at these levels there is no profit in them' (Firth 1959: 34–5).

Firth was pursuing a research agenda which sought to provide an understanding of the nature of phonological and phonetic categories: 'The

theory of *exponents*, linking the phonic data phonetically described with *categories* of phonology and grammar is a central necessity of linguistic analysis at congruent levels' (1957: vi). In undertaking this exploration he too was reacting against what he saw as the artificial and damaging separation of phonology from phonetics wherein neither gained benefit from developments in the other. He insisted that 'No phonetician listens fruitfully without what nowadays would be called a theory of phonology of some kind and indeed of general linguistics' (1957: vi). Indeed Firth argues that it is only by dealing with pieces of language which are clearly specified and constrained in terms of their phonological (and grammatical and lexical) structure that sensible interpretation of laboratory experimentation can be achieved. He also reminds us that no matter how sophisticated the experimental paradigms and techniques are, we need to reflect carefully on the *linguistic* adequacy of proposed categories being modelled: 'It is obvious that the validity of statistical methods and of other applications of mathematics depends on the elements of structure and units of systems set up by competent linguistic analysis' (1959: 29).

It goes without saying that since Firth's time phonological and phonetic theory have advanced, as has our understanding of the potential of 'laboratory' work to illuminate linguistic enquiry. It is all the more remarkable, then, that so many of Firth's concerns should resonate in the research agenda of LP characterised by Kingston and Beckman in 1990 and in the research presented in this volume.

What then is the enterprise of contemporary LP? Pierrehumbert *et al.* (1996) argue that 'Laboratory Phonology' is not a theoretical framework but rather a research community' (537). It might be more accurate to say that LP is constituted by 'the practices' of a research community that is seeking specifically to build bridges between experimental phonetics and theoretical linguistics in understanding the complex nature of language and the system(s) of constraints that govern it. Nonetheless, it is clear that while members of this particular research community may have different views on, say, the precise architecture of phonological theories, they do share aspirations, goals and approaches which impact on what kinds of phonological theories might be entertained and how claims might be tested. While LP is not prescriptive as to what constitutes 'laboratory investigation' or what constitutes a phonological theory, it does insist that if formal phonological claims are to be testable they need to be grounded in careful empirical *linguistic*-phonetic investigation and subjected to systematic laboratory experimentation which can provide for explicit modelling of results. The emphasis here on *linguistic*-phonetic investigation is important. Alongside the strong commitment to experimental research LP has always emphasised the need to ground such research in specific pieces of linguistic structure.

These concerns are well exemplified in the present volume, as are a number of recurrent themes in LP work. From its inception LP's central concern with finding ways of making robust, predictive statements about the way in which the sound systems in language function and are constrained has led it to explore three key areas:

- the question of what is the division of labour between phonetics and phonology – which phenomena belong where;
- the extent to which phonology is phonetically grounded – the extent to which language as a cognitive object can be/is to be accounted for in terms of general facts about the physical world;
- the nature of phonetic and phonological categories – the relationship between putatively discrete phonological categories and units and dynamic, continuous phonetic parameters.

These themes are enthusiastically taken up by the authors in present volume. They explore recurrent topics in LP (the phonetics–phonology interface, the physical constraints on phonological systems) and introduce new perspectives on issues such as lexical representation, linguistic constraints on phonetic variation and the extent to which phonological and lexical categories and structures constrain phonetic interpretation. Developments in LP are reflected in this volume by the increasing emphasis on perception rather than articulation and the role of functional considerations in shaping sound systems. A sense of the maturity and breadth of the work in LP can be gauged from the wide varieties of languages treated here which include Arabic, English (British and American), Danish, French, Italian, Korean, Japanese and Yorùbá.

One of the major contributions of LP which is reflected in this volume is the perspective on fundamental questions in phonology offered by paying attention to fine-grained phonetic detail. This has been achieved by its explicit goal of bringing phonology into the laboratory, and thus rooting phonology in the concrete world of what people/speakers do when they produce and perceive speech. The diversity and ingenuity of experimental design in the present volume testify to the richness of responses to this challenge. Approaches range from acoustic analysis of the speech waveform (e.g. Carter; Ladd and Scobbie; D'Imperio and Gili Fivela) to analysis of articulatory data using laryngography (Hayward, Watkins and Oyètádé), laryngoscopy (Zawaydeh) and electropalatography (Keating, Cho, Fougeron and Hsu) and from measuring reaction times to cross-spliced stimuli (Hawkins and Nguyen) to word-association tasks (Pierrehumbert, Hay, and Beckman) and perceptual simulation by training a recognition device (Nearey). The speech materials used in production experiments range from those read at the subjects' leisure (e.g. Carter; Ladd and Scobbie; D'Imperio and Gili Fivela) to the highly constrained speech-cycling task used by Tajima and Port. Equally, the interpretation of

results is frequently contextualised in ways which are not normally applied to phonological analysis. Thus Carter provides a convincing case for a particular model of phonetic interpretation by making reference to cross-dialectal patterning. Wright and Beckman and Pierrehumbert incorporate non-canonically phonological information of a very different kind in the form of sophisticated lexical frequency measures (and illustrate, by their co-occurrence in this volume, the application of such information in both production and perceptual studies).

In considering wider issues of lexical representation, Beckman and Pierrehumbert discuss the nature of phonological categories. They see phonological categories as formal syntactic objects which have three defining relations: (1) their semantics (cf. Pierrehumbert 1990), which is the phonetic interpretation of the category; (2) their paradigmatic relations with other items in the same system; (3) their syntagmatic relations with other items, i.e. their position in linguistic structure. This view is very like that of the Firthian prosodic analysts, whose theory had 'exponents', 'terms in system' and 'units in structure' as axiomatic. Like Beckman and Pierrehumbert, they viewed phonology as being part of a larger system, encompassing the lexicon, syntax, and wider, non-linguistic contexts, which includes the society in which a given language is spoken and the context in which it is used.

This view of phonology raises profound and challenging questions which have been themes in the discipline for decades. What is the nature of the relation between phonological categories and their phonetic interpretation? How many systems (and subsystems) can a language have, and how do we establish what they are? How is structure organised? What are the implications of system and structure for phonetic interpretation?

While the papers in this volume are very diverse, many are concerned with phonetics and its relation to phonology. One classic question of phonology is 'what constitutes a possible phonological inventory?', and several papers look at this issue, showing that phonological inventories can be shaped by phonetic constraints. The papers by Silverman and Hayward *et al.* investigate the relation between tone and voice quality. They look at issues of production and perception which constrain the combination of voice quality and tones in tonal inventories. Zawaydeh's paper considers the place of pharyngeals in Arabic. Other papers in the volume look at issues of timing. Gick and de Jong examine the possible interpretation of 'onset' and 'coda' in gestural accounts of American English, while Tajima and Port investigate the rhythmic structure of English and Japanese. As well as exploring relations between phonetics and phonological organisation, these papers provide new facts about the phonetic details of specific languages. This has been, and clearly continues to be, one of the main outcomes of Laboratory Phonology.

Another way to understand how phonetics is related to phonology is to consider *Grenzsignale*, phonetic stretches that unambiguously signal a particular phonological structure. Attention is drawn to this by Harris who argues that prosodic and morphological structures can be signalled by particular phonetic events because these structures differentially license the occurrence of interpretable phonological elements. Thus the phonetic signal is rich in information about phonological structure, which in turn characterises other linguistic structures. The paper by Keating *et al.* provides a more subtle understanding of this: they show that there is a significant systematic effect of higher-level prosodic structure on segment duration. D'Imperio and Gili Fivela show that the phonetic interpretation of structures which might have been subject to *Raddoppiamento Sintattico* is a complex product of the intersection of prosodic structure and information focus. They argue that the durational characteristics of consonants and vowels are constrained where the structures under consideration fall within particular kinds of information focus domain. Hawkins and Nguyen show that the temporal and spectral characteristics of onsets depend on codas; this is a smaller domain than those dealt with by Keating *et al.* and D'Imperio and Gili Fivela, but in each case, phonetic detail is closely associated with prosodic structure. Findings like these imply a close association of prosodic structure with phonetic detail, and they are more refined examples of classic *Grenzsignale*. As phonology continues its move away from rule-based frameworks to more structure-based frameworks, structure and the things that make it manifest become increasingly important.

The phonetic details reported in this volume are, in their very diverse ways, closely related to linguistic structure. Linguistic structure and the speech signal are in a symbiotic relationship with each other. Linguistic structure contains information of many types: syntactic structure, lexical frequency, semantic information, and so forth. This structure is part of the human cognitive system; the speech signal is its audible manifestation.

Many of the papers in the current volume are concerned with systematic phonetic detail. Some of this detail is subtle and hard to detect. But its systematic presence challenges traditional notions of what we mean by 'linguistic phonetics', which has generally cast aside 'detail'. Some of the details reported in this volume are clearly part of speakers' grammar, even though they do not contribute in any obvious way to establishing or maintaining lexical contrast, which has been the backbone of much phonology. These effects are more subtle: no doubt speech without them would be intelligible, but we can only hypothesise that without them, speech does not sound natural. The fact that even good speech synthesis often sounds unnatural is one way in which we can tell that systematic phonetic details contribute to overall impressions of 'naturalness'.

In other words, many of the systematic details we can observe in speech are a kind of syntagmatic glue: these details in some sense hold language together. Why might language be structured like this? One answer is that these details, however subtle, reflect and signal structural information. This facilitates the process of communication, since the speech signal contains information that relates to linguistic structure on many levels. In Hawkins' (1995) terms, they make speech 'perceptually coherent'. The challenge for phonology is how to explain such details. Perhaps if the notion of 'inventory' (a systematic listing of elements) is refined and a more polysystemic approach is taken, some of the frequency effects and variability observed in this volume and elsewhere would turn out to be artefacts of focusing too widely.

What are the types of thing which systematic phonetic detail is sensitive to? The papers in this volume give several different but complementary answers. Some of the details we can observe, such as those already remarked upon, relate fairly straightforwardly to linguistic structure. But others relate to things that are less conventionally thought of as important in phonological theory.

Wright shows that some details of vowel quality also depend on lexical frequency. Less frequent words have more peripheral, more hyperarticulated vowels than more frequent words, which have more central, more hypoarticulated vowels. Combined with the stochastic model of knowledge representation proposed in Hay *et al.*'s and Beckman and Pierrehumbert's papers, here we have evidence that phonetic detail reflects not only the discrete properties of the linguistic system, but also its continuous ones. Nearey's analysis of the factorability of phonological units (particularly syllables) into their parts takes a different point of departure. He explores the possibility that that symbolic units of no larger than a phoneme size play a major role in speech perception and argues that this role is modified by higher-order elements such as words in a 'highly limited and stylized way'.

Carter's paper shows that the exponents of 'clear' and 'dark' depend on the system in which these terms occur. Two laterals that in absolute, quantifiable, terms are the same count as 'clear' in one dialect but as 'dark' in another. Carter argues that words like 'clear' and 'dark' have no intrinsic semantics. In other words, the details of phonetic interpretation are language-specific; and the details may be far more complex than has traditionally been thought. This complexity, and its implications for phonological representation and phonetic interpretation, is highlighted by the fact that many 'mono-dialectal' speakers have passive knowledge of many varieties. In a wider social context, listeners partly identify dialects by details of this sort: as Firth put it, 'part of the meaning of an American is to sound like one' (Firth 1951: 120).

One of the conclusions to be drawn from this discussion is that speech is highly controlled behaviour. Phonetic details are closely associated with particular languages. To talk of some kind of universal or straightforward

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